Lead Exposure in a Firing Range

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Abstract: We report lead exposure in four employees of a privately owned shooting range, one of whom had neurological toxicity due to lead. Increasing time worked at the range was associated with elevation of blood lead. This incident emphasizes the risk of airborne lead exposure to employees of firing ranges. (*Am J Public Health* 1987; 77:1225–1226.)

Introduction

Exposure to lead in indoor firing ranges is a documented occupational hazard.[1–3] Airborne lead is generated by the action of hot propellant gases against the base of the bullet, by the friction of bullets against the gun barrel, when leaded bullets strike the target area, and by the combustion of lead in priming compounds.[4] Inadequate ventilation at a firing range and lack of personal protective equipment use by employees may result in lead poisoning of exposed employees.

In April 1985, the Colorado Department of Health (CDH) received a report from the director of a local health department concerning two persons with blood lead levels of 88 and 69 μg/dl. These persons were employed at a privately owned indoor firing range, and their lead levels were reported as part of routine medical monitoring by a physician. They had normal baseline blood levels reported in August 1983, when the range had opened (these results were unavailable to the investigators); the elevated blood lead levels were found in follow-up in April 1985.

Methods

In April 1985, each of the four employees at the firing range and three of their spouses agreed to have their blood sample drawn. A blood lead ≥30 μg/dl was considered evidence of recent lead exposure; an erythrocyte protoporphyrin (EP) of ≥50 μg/dl was considered evidence of exposure to lead in the last three months. Each person was administered a questionnaire to identify possible additional sources of lead exposure, including hobbies such as painting with lead-based paint, and food storage in lead-glazed pottery.

Blood lead by anodic stripping voltametry and EP analyses by extraction were performed by Environmental Sciences Associates, a reference laboratory used by the National Institute for Occupational Safety and Health (NIOSH). Follow-up blood samples for lead and EP were obtained on the exposed workers again in July 1985.

Air sampling was performed in the range using MSA Model G vacuum pumps* operating at 1.5 l/min with AA (37 mm) filters. Air samples were taken in the showroom, at the firing line, midway between the target and firing line, and as close to the target as possible. The air lead analysis was performed by the CDH laboratory using atomic absorption spectrophotometry.

Results

Blood lead levels and EP values for all persons are shown in Table 1. Case 1, the range manager, had the highest lead and EP levels, indicating both chronic and acute exposure. This person smoked more than one pack of cigarettes per day, often while cleaning lead dust and bullets out of the traps down range. Evaluation by an occupational medicine physician disclosed symptoms of intermittent headaches and right leg numbness and weakness. The physical examination demonstrated fasciculations and motor weakness in the right calf. This deficit was verified with nerve conduction velocity showing motor latency delay of the posterior tibial nerve. Neuropsychological testing was remarkable only for a mild learning disability, felt to be a pre-existing condition. On the basis of these findings, a diagnosis of neurological lead toxicity was made. The employee was advised not to clean the range and to avoid exposure to the range during use. Three months after diagnosis, the only residual symptom was a mild tremor of the calf; nerve conduction studies were normal. After six months, the patient's blood lead level had fallen to 43 μg/dl.

The blood lead and EP level of case 2 also indicated chronic and acute exposure, but this person declined to see a physician. The part-time employees had only slightly elevated blood leads and normal EP levels. None of the spouses had elevated blood lead or EP levels. Risk factors for exposure included increasing hours worked per week ($p = 0.008$, Linear regression) and increasing months worked at the range ($p = 0.02$, Linear regression). Smoking at work, eating at work, hours using the range for target practice, and other potential exposures were not associated with elevated blood lead levels. Use of protective clothing, showering on arrival home, and respirator use were not shown to affect the degree of lead absorption.

TABLE 1—Blood Lead and Erythrocyte Protoporphyrin Levels of Employees and Spouses at an Indoor Firing Range, Colorado, 1985

	Blood Lead (μg/dl)		Erythrocyte Protoporphyrin (μg/dl)	
Case Number	April	July	April	July
1(FT)	77	43	244	142
2(FT)	59	30	173	85
3(PT)	49	36	76	66
4(PT)	41	17	24	22
5(S)	6		22	
6(S)	11		34	
7(S)	6		29	

FT = Full Time employee
PT = Part Time employee
S = Spouse

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*Trade name is used for identification only and does not imply endorsement by the US Department of Health and Human Services or the US Public Health Service.

TABLE 2—Airborne Lead Concentrations at an Indoor Firing Range, Colorado, 1985

Location in Firing Range	Airborne Lead Levels in μg/m3
Showroom	2.7
Firing Line	13.6
Midway between Firing Line and Target	57.4*
Target	90.5*

* = Above OSHA permissible exposure level of 50 $\mu g/m^3$/8 hr-day

Table 2 lists the airborne lead concentrations at the range. The highest, 90.5 μg/m3 lead was found closest to the target. Technical difficulties in measuring air flow rates precluded adequate assessment of the ventilation system, but the flow rate recorded at installation was approximately 17,000 ft^3/minute; this is below NIOSH recommended guidelines of 20,000 ft^3/minute based on the dimension of this shooting range.[5]

Discussion

This incident emphasizes the risk of exposure to lead for employees in an indoor firing range. The Occupational Safety and Health Administration (OSHA) Permissible Exposure Level for lead in workplace air is 50 $\mu g/m^3$/8-hr working day. Air lead levels on the range suggest that the workers may have been exposed to potentially toxic lead levels while working in the contaminated down-range areas. Inadequate ventilation may also have contributed to the elevated blood lead levels found in the employees. An additional source of exposure to the two part-time employees, who recycled bullets at their homes, might have been lead suboxide particles thrown off during molten lead agitation in the bullet molding process.[2] The failure to find an association between behaviors known to increase lead absorption (such as smoking and eating in the shooting area) may be due to the small number of subjects.

The ventilation at the firing line was not measured or examined for turbulence. Patrons and employees alike could have been exposed to lead even with the low air levels measured in this investigation. Air lead sampling of exposed persons would have provided a better measure of exposure during maximum firing conditions.[5] Because the range had ceased operations due to unrelated reasons, further investigation regarding exposure to patrons was not possible.

Periodic blood lead and EP levels should be used to monitor exposed shooting range workers. Public health officials as well as range proprietors should be aware of design problems and work habits in ranges which allow exposure of employees and patrons. NIOSH has published guidelines for the construction, maintenance, and monitoring of firing ranges.[4,5]

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